

# SENIC—Nanoscale Science and Engineering

## Exploring Encapsulation for Drug Delivery

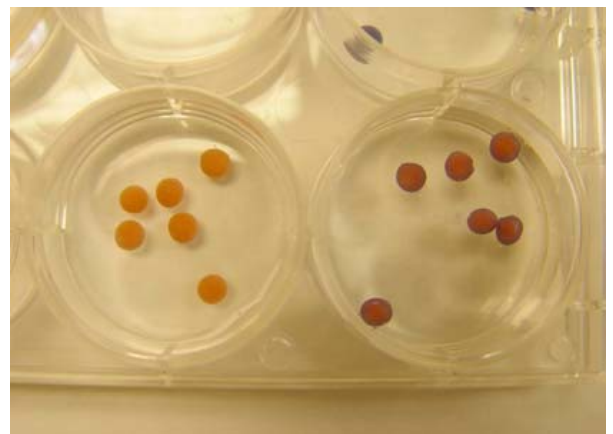
### Explore!

1. Place  $\text{CaCl}_2$  solution in upper and lower left wells. Place starch solution in center wells and iodine solution in top and bottom right wells.
2. Pipette drops of sodium alginate w/ iodine into upper  $\text{CaCl}_2$  well. What happens?
3. Take 1/2 of spheres and place in top starch solution well and the other half in top iodine solution well. What happens?
4. Pipette drops of sodium alginate with starch into lower left well.
5. Take 1/2 of spheres and place in bottom starch solution well and the other half in bottom iodine solution well. What happens?

### What is happening?

You have created a macro model of a self assembly process called encapsulation. Encapsulation is the trapping or enclosing of substances within a rigid external structure. There are various encapsulation approaches but the one explored here uses a gel to show how materials can be trapped inside and what effect the environment has on these materials.

Sodium alginate has carboxyl groups with a negative charge and the  $\text{CaCl}_2$  solution has calcium with a double positive charge. Combine the two and they cross-link to form the gel-like spheres. Placing the spheres in different solutions allows you to see how materials can be trapped within the spheres or how the external environment allows the materials to escape.



This demonstration is a model of how drugs could be encapsulated into nanoparticles (the spheres) and released at a particular cell for targeted drug delivery (change in external environment).

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### Forms of encapsulation:

**Molecular**—entrapment of one molecule inside a larger molecule

**Pharmaceutical**— entrapment of a chemical (medicine) inside a shell for drug delivery

**Micro-encapsulation**—microscopic particles are coated with another material (materials science)

### Some Uses of Encapsulation

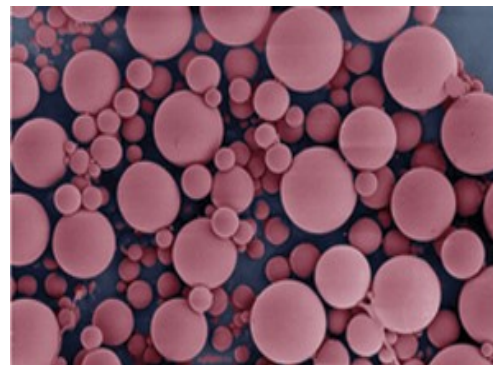
1. Carbonless paper/Smart Paper—microcapsules of dye “burst” under pressure and react with reagent on underlying paper.
2. Scented paper such as Scratch 'N Sniff™ - the paper has printed on it individual scented oil beads which break open with friction.
3. Drug delivery— targeted drug delivery using stimuli-responsive capsules that release chemicals when they reach the targeted cells. Controlled release can be triggered by chemicals, biological interactions, light, magnetism, heat, and electrical stimuli.

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4. Flavors— encapsulated flavoring agents can be added to foods—commonly used in jelly beans.



<http://publications.migms.nih.gov/findings/sept09/specialdelivery.asp>

5. Agriculture—Allows for slow release of fertilizers by using capsules with semi-permeable membranes.

This demonstration comes from: “Self-Assembly” from DragonflyTV Nano Educator’s Guide pages 50-51 <http://www.pbskidsgo.org/dragonflytv> or “Connecting Acids and Bases with Encapsulation....and Chemistry and Nanotechnology” from the Journal of Chemical Education , V84n7 p1136-1139 Jul 2007.